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THE METAPHORS OF PROSPECTIVE ELEMENTARY MATHEMATICS TEACHERS ABOUT THE CONCEPT OF GEOMETRY

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ABSTRACT

The aim of this study is to investigate the perceptions of prospective elementary mathematics teachers about geometry via metaphors. Participants of the study consist of 100 prospective elementary mathematics teachers at Sinop University, Department of Elementary Mathematics Education in Turkey. The data of the research has been obtained by completing the following sentence for each teacher candidate: "Geometry is like …; because …". Content analysis is used for the evaluation of the research data. A total of 53 different metaphors are produced by the participants and these metaphors are divided into a total of eight categories. As a result, it is understood that mostly "Puzzle" metaphor is produced and the category "Understanding Geometry and Strategy Use" has the most metaphors.

KEYWORDS: Geometry, metaphor, prospective mathematics teacher.

INTRODUCTION:

Geometry is the branch of mathematics concerned with the shape of individual objects, spatial relationships among various objects, and the properties of surrounding space. The word geometry is derived from Greek words and means earth measurement.

Many students have difficulties in geometry problem solving. In order to achieve success, it is necessary to identify the perceptions of students about geometry. Metaphors allow us to understand of an idea in terms of another. Conceptual metaphor theory started with the book Metaphors We Live By (Lakoff and Johnson, 1980) and is widely used in educational research. Noyes (2006) stated how metaphor theory was used to explore pre-service mathematics teachers' beliefs about mathematics and the learning and teaching thereof.

There are many studies of metaphorical perceptions on mathematics. In the studies of Güner (2013), Güler et al. (2012), Bahadır and Özdemir (2012), Şahin (2013) and Ersoy and Aydın (2017), metaphorical perceptions on the concept of mathematics were investigated by using metaphors. Çöl (2018) analyzed concepts of calculus via metaphors. Metaphorical perceptions of high school students related to geometry were examined in the study of Horzum and Yıldırım (2016).

Since metaphors of the concept of geometry have not been extensively studied, this study aims to determine the perceptions of prospective elementary mathematics teachers towards the concept of geometry via metaphors. Therefore, it is investigated which metaphors are used by prospective elementary mathematics teachers and which categories are generated from metaphors depending on their common points. Also, this study is important for the development of students' attitudes and behaviors in ways that may directly impact exam score while teaching geometry.

MATERIALS AND METHODS:

This study was carried out in the Department of Elementary Mathematics Education at Sinop University with 100 prospective elementary mathematics teachers. The research data was collected with the metaphor questionnaire for geometry. Participants were expected to complete the phrase "Geometry is like ...; because ...". They were requested to write a metaphor at first gap about geometry and reason of selected metaphor at the second gap.

Data collected from the prospective teacher's responses was evaluated by content analysis which is a research technique used to analyze various types of data. Patton (2002) indicates that content analysis requires considerably more than just reading to see what's there.

The metaphors produced by the participants were analyzed in four stages: stage of coding and eliminating, stage of collecting sample metaphor image, stage of category developing and stage of achieving validity and reliability. The research data was evaluated by software package such as Statistical Package for the Social Sciences (SPSS).

RESULTS:

According to the results of the evaluation of the questionnaires, it was observed that 53 different metaphors were produced from 87 participants. The majority of these metaphors (f=44) were produced by a single participant. Metaphor-free forms and blank forms (f=13) were not evaluated. The most frequently used metaphor is puzzle (f=19). The second most produced metaphor is labyrinth (f=5). The metaphor "picture" (f=4) is the third most produced metaphor. While the metaphors "book", "game" and "jigsaw puzzle" are produced three times, the metaphors "art", "mountain" and "Rubik's cube" are produced twice. Except all these metaphors, the others are produced once. In Table 1, the metaphors produced by participants are listed in alphabetical order and the frequencies and percentages of the metaphors are given.

Table1: Metaphors Produced for the Concept of Geometry

Metaphors	f	%	Metaphors	f	%
Amusement park	1	1,1	Mountain	2	2,3
Art	2	2,3	Muscle	1	1,1
Barbed wire	1	1,1	Musical note	1	1,1
Bird in the sky	1	1,1	Ocean	1	1,1
Book	3	3,4	Okey 101 game	1	1,1
Cage	1	1,1	Pencil	1	1,1
Cave	1	1,1	Philosophy	1	1,1
Chess	1	1,1	Picture	4	4,6
Closed box	1	1,1	Port	1	1,1
Compass	1	1,1	Puzzle	19	21,8
Cycling	1	1,1	Rainbow	1	1,1
Ever changing weather	1	1,1	Recycle bin	1	1,1
Faded flower	1	1,1	Rubik's cube	2	2,3
Game	3	3,4	Sandbag	1	1,1
Gas pain	1	1,1	Space	1	1,1
Growing tree	1	1,1	Stairs	1	1,1
Guitar	1	1,1	Sudoku puzzle	1	1,1
Invention	1	1,1	Table	1	1,1
Jigsaw puzzle	3	3,4	The language of nature	1	1,1
Kite	1	1,1	Tree	1	1,1
Kiwi	1	1,1	Walking	1	1,1
Labyrinth	5	5,7	Walking in nature	1	1,1
Lego	1	1,1	Waste matter	1	1,1
Life	1	1,1	Weather	1	1,1
Meal	1	1,1	Woman	1	1,1
Meat	1	1,1	Word puzzle	1	1,1
Meatball	1	1,1			
Total	f=87				

Metaphors are divided into eight different categories in terms of common characteristics regarding geometry. These categories are "enjoyable geometry/ game", "the difficulty of geometry", "interest and attitude to geometry", "labor, importance and necessity of geometry", "the content of geometry", "understanding geometry and strategy use", "small details in geometry" and "visuality in geome-

try". Most metaphors are produced in the category "understanding calculus and strategy use". The most produced metaphor "puzzle" is categorized under three different categories "enjoyable geometry/ game" (f=6), "understanding geometry and strategy use" (f=8) and "small details in geometry" (f=5). In Table 2, the categories of metaphors, the frequencies and percentages of the categories are given.

Table 2: Categorical Distribution of Metaphors

Categories	f	%
Enjoyable geometry/ Game	18	20,7
The difficulty of geometry	6	6,9
Interest and attitude to geometry	6	6,9
Labor, importance and necessity of geometry	6	6,9
The content of geometry	5	5,7
Understanding geometry and strategy use	27	31,0
Small details in geometry	12	13,8
Visuality in geometry	7	8,0
Total	87	100

Enjoyable Geometry/ Game:
The category "enjoyable geometry/game" was determined by the common properties based on geometry being enjoyable and being as a game. It consists of 11 different metaphors produced by 18 participants. The most recurring metaphors are puzzle (f=6) and game (f=3). The other metaphors were produced by one participant for each. These metaphors are amusement park, guitar, labyrinth, Lego, meal, Okey 101 game, sandbag, Sudoku puzzle and word puzzle. This category has 20,70 percent of total metaphors and the second most metaphors.

The Difficulty of Geometry:
This category was created based on difficulty of geometry. It includes 6 different metaphors and all metaphors were produced by one participants for each. These metaphors are barbed wire, cage, ever changing weather, gas pain, mountain and woman.

Interest and Attitude to Geometry:
This category was created based on the participant's dislike or like of geometry, fear of geometry, willing to learn geometry, getting bored with geometry, feeling of helplessness, hopelessness and sadness, etc. This category contains 6 different metaphors and all metaphors are produced once. These metaphors are kiwi, life, port, walking, waste matter and weather.

Labor, Importance and Necessity of Geometry:
This category was determined by the common properties based on demanding labor and skill, importance and necessity of geometry, etc. The category includes 6 different metaphors produced by 6 participants. The metaphors are growing tree, book, faded flower, invention, meat and pencil.

The Content of Geometry:
This category was created based on content of geometry. It consists of 5 different metaphors and all metaphors are produced once. This category has 5,70 percent of total metaphors and the least metaphors. These metaphors are closed box, muscle, ocean, Rubik's cube and space.

Understanding Geometry and Strategy Use:
This category was determined based on methods in geometry, strategy use, and understanding geometry. It consists of 16 different metaphors produced by 27 participants. The most produced metaphor "puzzle" (f=8) is categorized by repeating eight times in this category. While the metaphors "jigsaw puzzle" (f=3) and labyrinth (f=3) are produced three times, the others are produced once. The metaphors are book, cycling, walking in nature, recycle bin, kite, meatball, mountain, philosophy, compass, Rubik's cube, chess, stairs and table. This category has 31,00 percent of total metaphors and the most metaphors.

Small Details in Geometry:
The category "small details in geometry" was created based on the importance of small details in geometry. This category includes 8 different metaphors produced by 12 participants. The most produced metaphor "puzzle" is repeated five times in this category. The others are produced once. These are art, bird in the sky, cave, labyrinth, rainbow, tree and picture. This category has 13,80 percent of total metaphors and the third most metaphors.

Visuality in Geometry:
This category was determined by the common property based on visuality in geometry. It contains 5 different metaphors by 7 participants. The metaphor "picture" is produced three times and the others are produced once. These metaphors are art, book, the language of nature and musical note.

DISCUSSION:
In metaphorical perceptions of teacher candidates on the concept of geometry, three important categories are foregrounded. These categories are "enjoyable geometry/ game", "small details in geometry" and "understanding geometry and strategy use". In the category "enjoyable geometry/ game", prospective mathematics teachers indicate that solving questions of geometry is enjoyable and like a game. In the category "small details in geometry", prospective mathematics teachers indicate that it makes easy to solve problems in geometry when important details in question are noticed. In the category "understanding geometry and strategy use", prospective mathematics teachers point out methods of solving problems and importance of strategy use. The results obtained in three categories show that teacher candidates are aware of importance of strategies, methods, small details while solving geometry problems and they enjoy solving problems. Similar studies can be carried out with prospective teachers at other universities and the results can be compared.

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